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PRELIMINARY SPAWNING BIOMASS ESTIMATE OF THE NORTHERN ANCHOVY IN 1988

By

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ABSTRACT

The preliminary spawning biomass estimate of the northern anchovy in 1988 is 949,000 mt. The estimate was made by application of the stock Synthesis (SS) Model which utilizes time series of both abundance data and age composition data; anchovy landings from both U.S. and Mexico; and sea surface temperature. As the age composition in 1987 was not available at the time of writing, 1986 age data were used in the analysis. The final spawning biomass will be computed when 1987 age data are available.

INTRODUCTION

This is a report on the estimate of the 1988 spawning biomass of the central subpopulation of the northern anchovy (Engraulis mordax). The Southwest Fisheries Center (SWFC) is required to estimate the spawning biomass according to the provisions of the Anchovy Management Plan of the Pacific Fishery Management Council (PFMC 1983). In 1980-85, the spawning biomass was estimated by the egg production method (EPM) (Lasker 1985). Beginning in 1986, however, the estimate was computed by the Stock Synthesis (SS) Model (Methot 1986, Methot and Lo 1987). The SS Model integrates the EPM observation with other data. These data include biomass indexes, age composition from U.S. and Mexican fisheries, age composition from California Department of Fish and Game (CDF&G) surveys, and environmental data. Although four time series of abundance data are utilized in the Model, the new data point in 1988 is the modified historical egg production (MHEP) which is computed from plankton samples in the California Cooperative Oceanic Fisheries Investigation (CalCOFI) survey. Because the 1987 age composition data were not ready, I used the 1986 age data from the Mexican fisheries under the assumption that the 1987 age composition was similar to that of 1986. The estimate will be revised when the 1987 age data are in hand.

DATA

The total landings at Ensenada during 1987 were 124,000 mt (compared to 96,000 mt in 1986), which is 62% of the 200,000 mt optimum yield. The total landings from U.S. fishery were 5,900 mt of which 148 mt was for reduction; landings in 1986 were 5,500 mt.

Plankton samples collected on Jan 19 - Feb 2 ,1988 CalCOFI cruise were used to compute the MHEP . Analysis of egg and young larvae indicated daily egg mortality of -0.53 per day in 1988 (Table 1). The estimated egg production rate for 1988 was $6.9/0.05m^2$/day (SE=4.83),similar to 7.2(SE=2.57) in 1986 and 7.6(SE=3.34) in 1987. An average of 3.1 in 1980-85 suggests that the biomass in 1988 remains a level higher than EPM biomass estimates in 1980-85 period (Table 1).

During Jan-Feb 1988, the temperature at the pier of the Scripps Institution of Oceanography (SIO) was 13.9°C , a decrease from 15°C in 1987 and 15.2°C in 1986 (Table 2) . At this temperature, the temperature-maturity relation estimates that 63% of the age 1 fish are sexually mature and 33% of them are actively spawning, hence contributing to the MHEP index .

As mentioned earlier, no age composition data of 1987 were available at the time of analysis, yet they are a necessary input to the SS Model. Therefore, I used age data from previous years. I examined the age composition data of 1984-1986 for short term year-to-year change in age composition. The age composition in the fourth quarter for all three years was similar: 70% were 0-year-olds, 22% were 1-year-olds, and 8% were older fish. For simplicity, I assumed that 1987 age composition was similar to that of 1986 (Table 4 of Methot and Lo 1987). When 1987 age data are available, a new estimate of the spawning biomass will be provided.

One of the major sources of natural mortality of northern anchovy is the predation by Pacific mackerel (Methot 1986). Pacific mackerel biomass was estimated to be in the range 374,000 - 1 million mt on July 1, 1987, and projected to be 290,000 mt on July 1, 1988 (pers. commn. Patty Wolf, CDF&G). The decrease of biomass was partially due to the change of estimation procedure. At this level of mackerel biomass, natural mortality of anchovy increases from the nominal level of 0.6 to a level of 0.7 per year.

RESULTS AND DISCUSSION

The spawning biomass in February 1988 is estimated to be 949,000 mt (Table 3, Figure 1). Although this value is a slight decrease from 1,212,000 mt in 1987 (Methot and Lo 1987), it is

still higher than the 1985 spawning biomass of 521,000 mt estimated by the EPM. The high level of spawning biomass was partially due to the high egg production rate estimated from MHEP (Figure 2), assuming the adult reproduction output remains constant.

The 1987 spawning biomass from 1964-1988 time series is 828,000 mt compared to 1,212,000 mt from 1964-1987 time series (Methot and Lo 1987). The discrepancy could well be caused by the assumed age composition.

The preliminary results from the SS Model indicate that the population in 1988 remains at a similar level as that of 1987, which is consistent with MHEP series. If the age composition in 1987 is drastically different from that in 1986, the final results will be altered.

Two other spawning biomass estimates were computed for 1988. One estimate was based on the EPM where the number of newly spawned eggs per day was estimated from 1988 CalCOFI survey data and the adult parameters were the averages in 1980-82 and 1985. The 'EPM' spawning biomass estimate was 730,000 mt(SE=0.12). The other estimate was based on the results from two time series :1964-1987 and 1964-1988 using the SS Model. The estimate was 1,389,000 mt (=1,212,000x949/828)(Table 3). The preliminary spawning biomass estimate of 949,000 mt is within the range of estimates from other two methods, and is believed to be sufficient for quota setting for 1988.

For age composition information in 1951-87 , the reader should refer to Methot and Lo (1987). Detailed tables on estimates of parameters in SS Model,updated age composition, weight at age and pattern of age-specific availability for the 1988 biomass estimate will be included in a later report on the final analysis which will include 1987 age composition.

ACKNOWLEDGEMENTS

I thank all those who contribute to the spawning biomass estimate, in particular to those individuals who collected, sorted, staged and processed the plankton samples from the January 1988 CalCOFI cruise, and all crew members of the NOAA ship David Starr Jordan.

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Table 1. EPM is spawning biomass (thousand mtons) estimated by the egg production method , HEP is the Historical Egg Production index of spawning biomass (Lo, 1985) and as modified to account for the reduced CalCOFI sampling pattern (MHEP). Z is the egg mortality associated with the HEP estimate and which was used in making the MHEP estimate. Sonar is based on the acoustic surveys conducted by CDF&G. Standard errors are in parentheses.

Year	EPM	HEP	MHEP	Z	SONAR
51	***	0.012 (0.12)	0.011 (0.06)	0.23 (2.18)	***
52	***	0.017 (0.11)	0.024 (0.14)	.09 (1.27)	***
53	***	0.066 (0.18)	0.035 (0.08)	.19 (0.54)	***
54	***	0.168 (0.19)	0.177 (0.18)	.12 (0.24)	***
55	***	0.316 (0.34)	0.360 (0.41)	.07 (0.26)	***
56	***	0.146 (0.65)	0.476 (2.21)	.33 (0.88)	***
57	***	0.364 (0.42)	0.444 (0.47)	.20 (0.25)	***
58	***	1.274 (1.18)	1.718 (1.23)	.43 (0.23)	***
59	***	0.992 (0.82)	1.777 (1.31)	.23 (0.20)	***
60	***	1.765 (0.77)	2.443 (1.20)	.24 (0.10)	***
61	***	0.653 (0.64)	0.706 (0.61)	.29 (0.22)	***
62	***	1.314 (1.17)	2.248 (1.66)	.19 (0.18)	***
63	***	2.275 (0.99)	2.967 (1.39)	.28 (0.09)	***
64	***	4.147 (2.68)	8.643 (4.59)	.42 (0.13)	***
65	***	4.019 (1.18)	8.177 (2.91)	.19 (0.06)	***
66	***	5.256 (1.80)	12.851 (5.12)	.42 (0.07)	***
67	***	***	***		***
68	***	***	***		***
69	***	3.821 (1.06)	5.431 (1.55)	.19 (0.06)	438.
70	***	***	***		275.
71	***	***	***		233.
72	***	1.657 (0.80)	3.450 (0.83)	.25 (0.11)	822.
73	***	***	***		1671.
74	***	***	***		947.
75	***	19.691(10.36)	16.707 (3.96)	.44 (0.11)	3086.
76	***	***	***		***
77	***	***	***		1984.
78	***	2.33 (4.48)	14.657 (6.53)	.59 (0.10)	392.
79	***	5.426 (2.62)	5.070 (2.19)	.48 (0.10)	292.
80	870.	2.671 (1.26)	2.548 (0.99)	.36 (0.08)	604.
81	635.	4.376 (2.08)	4.738 (1.78)	.38 (0.08)	567.
82	415.	3.29 (1.36)	1.684 (2.03)	.36 (0.09)	250.
83	652.	3.91 (1.17)	1.654 (1.27)	.46 (0.06)	532.
84	309.	2.85 (1.06)	2.567 (1.76)	.36 (0.08)	573.
85	521.	2.62 (0.67)	5.160 (2.16)	.28 (0.05)	1015.
86	***	***	7.558 (3.34)	.34 (0.12)[a]	***
87	***	***	7.234 (2.57)	.19 (0.08)[a]	***
88	***	***	6.891 (4.83)	.53 (0.09)[a]	***

[a]Z for 1986 - 1988 computed from the condensed CalCOFI area.

Table 2. Time series of environmental deviations and weight at age deviations. Deviations are calculated from monthly means then averaged into quarters. Environmental deviations are lagged -1 month (e.g. quarter 1 contains average Dec-Feb deviation). Temp is the surface temperature at the SIO pier. Sea level is the sea level at the SIO pier(Prager and MacCall 1986). WTDEV-US and WTDEV-MX are average weight at age deviations for ages 2-4 based on data from the commercial reduction fishery at San Pedro in the U.S. and ages 1-3 at Ensenada in Mexico.

Year	Qtr.	Temp.	Sea Level
51	1	-.523	-.863
51	2	-.084	-.147
51	3	-.221	.355
51	4	-.289	.626
52	1	-.336	-.188
52	2	-.290	-.241
52	3	-.816	-.711
52	4	-1.027	-.026
53	1	-.461	-.023
53	2	-1.011	-.283
53	3	-.300	-.243
53	4	-.908	-.111
54	1	-.149	-.087
54	2	-.435	.053
54	3	.553	.399
54	4	-.574	-.449
55	1	-.635	-.496
55	2	-.714	-.144
55	3	.036	-.130
55	4	-.134	-1.117
56	1	-1.322	-1.256
56	2	-.851	-.263
56	3	-.229	-.049
56	4	-.366	-.632
57	1	.495	-.136
57	2	-.002	.461
57	3	.866	1.439
57	4	.097	.870
58	1	1.901	1.372
58	2	.956	1.255
58	3	-.274	.621
58	4	1.437	1.427
59	1	1.592	1.111
59	2	1.655	.930
59	3	1.275	.858
59	4	1.523	1.083
60	1	.282	.265
60	2	.500	.193
60	3	-1.092	-.011
60	4	-.204	.023

Year	Qtr.	Temp.	Sea Level	WTDEV-US	WTDEV-MX
61	1	.107	.185		
61	2	-.183	-.189		
61	3	-.622	-.048		
61	4	-.979	-.370		
62	1	-.634	.275		
62	2	-.666	-.599		
62	3	-1.260	***		
62	4	-.355	***		
63	1	.156	.216		
63	2	-.494	-.231		
63	3	-.131	.684		
63	4	.397	.779		
64	1	.900	.188		
64	2	-.935	-.789		
64	3	-.402	-.735		
64	4	-.797	-.599		
65	1	-1.122	-.056		
65	2	.295	.476		
65	3	-1.351	.212		
65	4	.020	.841		
66	1	-.074	.836		
66	2	.274	.634		
66	3	.532	.607		
66	4	-.065	-.077		
67	1	-.178	.231	.34	
67	2	-.680	-.433	.56	
67	3	.021	.277	***	
67	4	1.050	.139	***	
68	1	-.005	.436	***	
68	2	.142	.084	***	
68	3	-.007	-.206	***	
68	4	-.040	.332	.79	
69	1	-.141	.591	1.01	
69	2	-.547	.360	-.29	
69	3	-.563	.333	***	
69	4	-.283	.788	1.99	
70	1	-.124	-.324	1.68	
70	2	.059	-.115	.18	
70	3	-.403	.004	2.37	
70	4	-.107	-.111	1.95	
71	1	-.819	-.528	2.95	
71	2	-1.580	-.285	1.38	
71	3	.958	.314	***	
71	4	-1.022	.121	-1.23	
72	1	-1.716	-.056	-.25	
72	2	-.164	.735	-1.31	
72	3	.451	1.573	***	
72	4	.156	1.523	-2.90	
73	1	1.051	1.387	***	
73	2	-.354	.056	-2.62	
73	3	-.489	-.300	-2.37	
73	4	-1.285	-1.192	-.45	

Year	Qtr.	Temp.	Sea Level	WTDEV-US	WTDEV-MX
74	1	-1.114	-.455	-2.30	
74	2	-.494	.767	-1.20	
74	3	-.425	.922	***	
74	4	.185	.286	-1.06	
75	1	-1.041	-.370	1.34	
75	2	-1.668	.160	2.40	
75	3	-1.481	-.186	.47	
75	4	-1.494	-.269	.69	
76	1	-.646	.068	2.12	
76	2	-.412	.904	2.77	
76	3	-.259	.848	.69	
76	4	1.539	1.412	.03	
77	1	2.144	1.089	***	
77	2	-.282	-.073	.28	
77	3	-.508	.351	1.17	
77	4	.474	.819	1.12	
78	1	1.562	1.730	***	
78	2	1.181	1.217	***	
78	3	-.422	.219	***	.84
78	4	.783	.886	.85	2.36
79	1	-.546	.880	***	***
79	2	-.301	.784	0.95	0.41
79	3	.157	.470	***	.29
79	4	.086	.302	***	.34
80	1	.524	1.693	***	***
80	2	.296	1.408	-.18	0.22
80	3	-.999	.797	***	.74
80	4	-.883	.481	-1.26	1.15
81	1	.242	.713	***	***
81	2	1.061	1.590	-.44	-.48
81	3	1.472	1.115	***	-1.29
81	4	.073	.380	-.74	-.14
82	1	-.093	.387	***	***
82	2	.282	1.311	.51	.59
82	3	-.131	1.221	***	-.42
82	4	.559	2.752	***	.03
83	1	1.393	3.158	***	-3.24
83	2	.808	2.607	***	-3.11
83	3	.200	3.471	***	-3.03
83	4	1.965	2.480	***	-4.41
84	1	.924	1.068	***	-3.00
84	2	1.091	2.159	***	-1.53
84	3	2.184	2.464	***	-2.26
84	4	2.000	1.616	***	-3.54
85	1	-.427	***	***	***
85	2	.015	***	***	2.89
85	3	.614	***	***	***
85	4	.953	***	***	3.94
86	1	.602	***	***	***
86	2	1.258	***	***	-.97
86	3	.130	***	***	1.67
86	4	.734	***	***	1.93
87	1	1.230	***	***	***

Year	Qtr.	Temp	Sea Level	WTDEV-US	WTDEV-MX
87	2	1.355	***	***	***
87	3	-.718	***	***	***
87	4	1.566	***	***	***
88	1	-.083	***	***	***
88	2	1.198	***	***	***

Table 3. Time series of estimated biomass and recruitment. Biomass estimates are in units of thousand metric tons as of Feb. 15 of the indicated year. Recruitment estimates are in units of 50 billion age 0 fish as of July 1 of the indicated year.

Year	Total Biomass	Spawn. Biomass	Recruitment
1964	776	767	0.479
1965	704	602	0.195
1966	535	510	0.173
1967	372	356	0.529
1968	359	340	0.490
1969	383	356	0.577
1970	407	311	1.721
1971	734	321	1.651
1972	1055	614	2.268
1973	1427	1401	2.279
1974	1677	1128	0.809
1975	1400	1216	0.374
1976	1009	960	1.107
1977	823	822	0.282
1978	454	453	2.098
1979	817	543	1.713
1980	762	754	1.529
1981	807	770	0.559
1982	467	427	1.663
1983	543	526	0.755
1984	381	375	1.574
1985	695	542	1.324
1986	734	725	1.792
1987	846	828	3.000
1988	1236	949	---

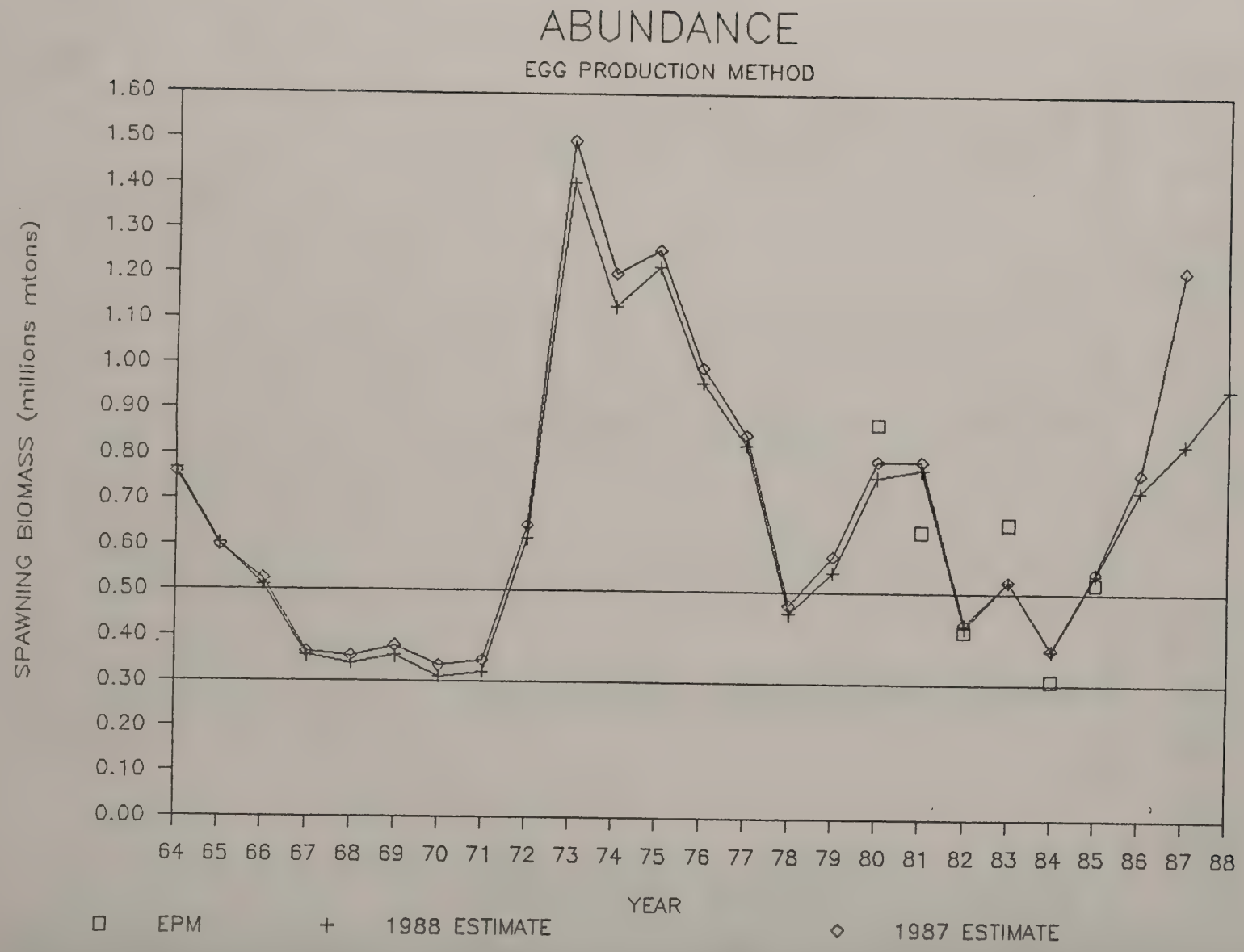
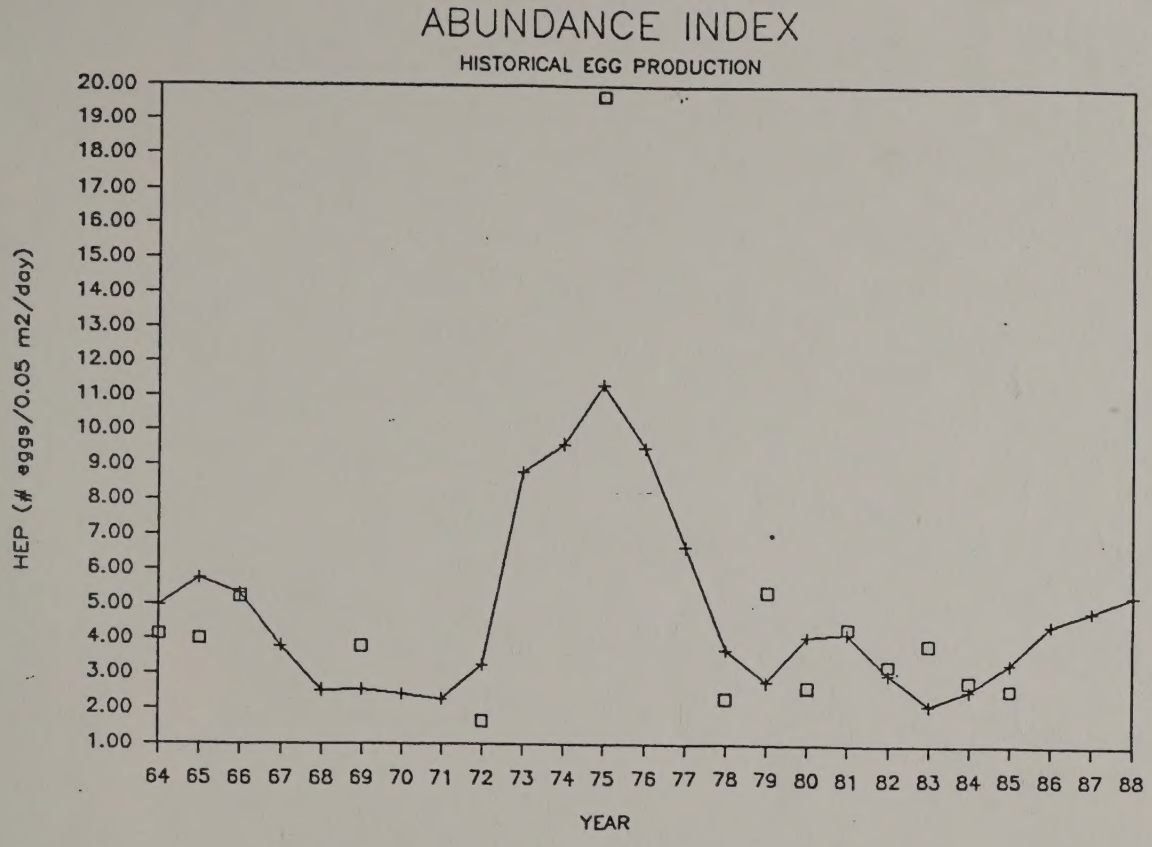


Figure 1. Estimated time series of spawning biomass and observations made by the Egg Production Method



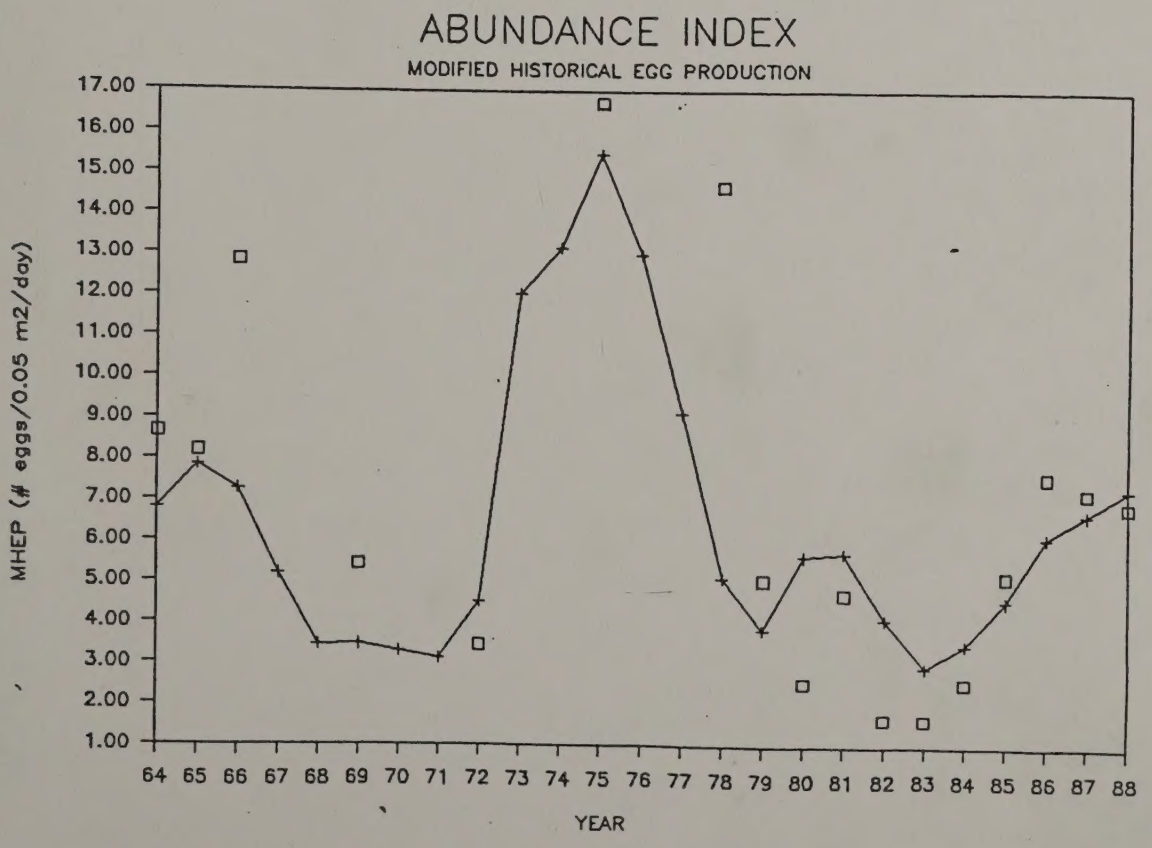


Figure 2. Estimated and observed time series of Historical Egg Production (Lo 1985) and modified HEP for the current restricted CalCOFI survey area.